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Work Scheduling on Canadian Coast Guard Ships

Physiological and Psychological Impacts

SUMMARY REPORT

September 1989

by

Le groupe interdisciplinaire de recherche sur l'organisation, la santé et la sécurité du travail (GIROSST), Université Laval

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16. Abstract

A study was undertaken on the Canadian Coast Guard ship *Simon Fraser* (search and rescue) to examine the physiological and psychological impacts of 12-hour schedules over 28 consecutive days. Review of the literature, ergonomic analysis, and a systematic chronobiological study of 13 crew members made it possible to demonstrate that daily 12-hour schedules were just as disturbing as six-hour schedules with a night watch. Those working days on six-hour watches felt the least disturbance. Over the month, the first nine days were disturbed, but there does not seem to be any difference between the following two periods (10 to 19 and 20 to 28 days). This study made it possible to recommend a new work schedule for crew members.

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16. Résumé

Une étude a été entreprise sur le NGCC - *Simon Fraser* (recherche et sauvetage) afin d'examiner les impacts physiologiques et psychologiques des horaires de 12 heures pendant 28 jours consécutifs. L'examen de l'état des connaissances, une analyse ergonomique et une étude chronobiologique systématique de 13 membres d'équipage ont permis de montrer que les horaires de 12 heures de jour étaient tout aussi perturbateurs que les horaires six en six avec quart de nuit. Les personnes les moins perturbées oeuvraient de jour, sur des quarts (six en six). Dans le mois, les premiers 9 jours sont perturbés, mais il ne semble pas y avoir de différence entre les deux périodes suivantes (10 à 19 et 20 à 28 jours). L'étude a permis de recommander un nouvel aménagement de travail pour les membres de l'équipage.

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INTRODUCTION

The purpose of the present study was to collect systematic data on the physiological and psychological repercussions of work schedules in effect on Canadian Coast Guard ships. Our task was essentially to document the effects of the schedules, in order to increase their efficiency, and to suggest a number of changes applicable to all ships. These schedules have a number of special characteristics: daily 12-hour schedules take place within a cycle of 28 consecutive working days followed by an equal period of rest; the entire crew is affected. Not only does work at sea have particular features, but the very mission of the ship on which "on-site" data collection was carried out is special, i.e. search and rescue work.

The relationship between work schedules on the one hand and worker health and performance, on the other, has been shown in a number of scientific studies. However, the schedules in effect on the CCGS Simon Fraser have been practically ignored. These schedules took two forms: six-hour watches and daily, round-the-clock 12-hour schedules.

In order to attain its objective, the report has three distinct parts:

Part A: Synthesis of knowledge

Part B: Ergonomic analysis

Part C: Chronobiological study

Conclusions and recommendations follow.

Part A

SYNTHESIS OF KNOWLEDGE AND METHODOLOGICAL CHOICES

We speak of "round-the-clock operation" when work continues 24 hours a day and seven days a week (Quéinnec et al., 1985).

Like any shift work, round-the-clock operation engenders specific problems because of the "abnormality" of the working hours – abnormal in that most often they go against the natural activity-rest rhythm adjusted to the alternation between day and night.

This natural activity-rest rhythm is matched by a certain structure in biological rhythms, stable for each individual. Let us examine in more detail what these biological rhythms are.

A biological rhythm may be compared with a sine wave, characterized by four parameters: period, phase, amplitude and mid-point. The rhythms involved here are circadian, that is, 24-hour rhythms. The functions affected by these rhythms may be physiological (such as body temperature, growth hormones, and concentration of cortisol and potassium in the organism) or psychological (such as memory, alertness, and colour recognition).

There are three important characteristics of circadian rhythms (Aschoff, 1978):

1. They are stable: even without any external time indicators (such as in the lab or at the bottom of a cave), we find cycles of approximately 24 hours. They are in fact of genetic origin (Reinberg and Ghata, 1982).

2. They persist even when the alternation of activity and rest periods is disturbed (thus even in the case of round-the-clock operation).

3. They may be desynchronized and resynchronized completely or in part.

In the case of round-the-clock operation, there is manipulation of the synchronizer which is preponderant for the human race, that is, the alternation of rest and activity (Reinberg and Ghata, 1982). Many studies show that rhythm adjustment is only partial and that there is desynchronization. On the other hand, a day of rest is most often sufficient for a worker on the night shift to regain a normal cycle (Carpentier and Cazamian, 1977).

The literature on this subject shows that disturbances in biological rhythms brought on by round-the-clock operation seem closely linked to health problems suffered by certain workers.

What is the impact of these disturbances on human performance?

The link between round-the-clock operation and performance is rather complex. Almost all studies on the subject, whether conducted in the laboratory or in the field, agree that there is a circadian rhythm in human performance.

However, an important distinction must be made. Vries-Griever and Meijman (1987) identified two types of tasks:

Type I tasks
Physical and mental tasks based on the application of rules and skills acquired by learning (well-trained skills), essentially involving first-level information.

Type II tasks
Mental tasks requiring attention and a heavy burden on working-memory, which are based on knowledge and reasoning and which essentially involve a high-level information processing mode (called "controlling level of information processing" by cognitivists).

Research on this subject makes it possible to conclude the following:

- Performance is affected by not one but several circadian rhythms, which vary according to the task to be carried out, its requirements, and the psychological processes it brings into play.

- The execution of simple and repetitive tasks (Type I) follows a rhythm linked to that of body temperature; performance is better during the day (maximum at the end of the day) than at night.

- The execution of more complex tasks (Type II) follows the inverse rhythm: it seems to be better at night than during the day but not according to all optimization criteria (precision vs. speed of execution), and, at any rate, is achieved at the expense of the individual; the same task with more difficult constraints (night work, in a deactivation period) results in an overload on the individual.

More specifically with reference to work at sea, whether daily schedules are eight or twelve hours, a number of characteristics should be pointed out:

- This is a single living environment (work and recreation) during a long period of time (closed environment).

- The concept of rest and recreation does not have the same meaning at all for work at sea as for work ashore (no conflicts created by the constraints of family life or of existing evening and week-end recreation, or with the need to commute to work).

- Work at sea takes place in a very specific environment, with continuous movement whose strength changes with meteorological conditions, noise (from engines and electrical generators), and vibration. These constraints may affect workers during recreation and rest periods and, in particular, disturb their sleep.

- The presence of a minimum crew is needed day and night to ensure safe and proper functioning of the ship at all times. This brings us to the problem of round-the-clock operation at sea.

- Schedules for shift work at sea are different from those seen in other sectors because of the special nature of tasks carried out and the continuous availability of crew (due to the elimination of commuting time). Some surveillance activities cannot take place over too long a period without jeopardizing the safety of ship and crew.

The above considerations have lead to two types of schedules: three-crew systems (eight hours of work a day) and two-crew systems (12 hours of work a day).

Some studies have examined the impact of work at sea under the usual schedules. The following conclusions may be noted:

1. The specific characteristics of the work environment at sea, mentioned above, influence the relationship between work schedules and biological rhythms.
2. The work environment and its constraints (movement, vibrations, etc.) lead to particular sleep problems which probably generate additional disturbance and fatigue.
3. The total quantity of sleep is less than that found within a comparable population not subject to the constraints of work at sea. Daytime sleep is less efficient in terms of quality.
4. Adaptation of rhythms to schedules is only partial, but desynchronization does occur.
5. Speed and alertness in carrying out tasks are poorest at night.
6. Lack of sleep is the main factor responsible for the disturbances observed.

In considering more specifically the impact of six-hour schedules, the few studies available found that:

- Sleep is broken into two periods.
- Certain rhythms (i.e., temperature) flatten out after ten or twelve days.
- Certain rhythms (i.e., mercury) are more resistant than others (potassium), when urinary excretions are analyzed.
- There is partial adaptation in performance.

Consideration of the particular situation on the CCGS *Simon Fraser* led to the following decisions:

- There is a need for an ergonomic analysis and a chronobiological study.
- The ergonomic analysis should deal with the ship's activity in general as well as the tasks of each individual studied.
- The 13 crew members who agreed to take part in the study were divided into three groups, each with a different work schedule:

Group 1:
This group works from 0000 to 0600 and from 1200 to 1800. It is made up of four crew members and is the only one to keep a real night watch.

Group 2:
This group works from 0600 to 1200 and from 1800 to 2400. It is also made up of four crew members.

Group 3:
This group of five members works 12 hours a day, from 0600 to 1930 with three rest breaks of a half-hour each (0730, 1130 and 1730).

- The most important physiological parameters examined were:
  - Body temperature
  - Heart beat
  - Potassium excreted in the urine.
- The psychological impacts were measured by:
  - An alertness test or an adaptation of the Bakan test (presentation on a microcomputer screen of a letter or figure; the respondent must detect the letter-figure-letter sequences as quickly as possible) which permits measurement of three variables: errors of omission, errors of commission, and reaction time.
  - Questionnaire on drowsiness (the Stanford Sleepiness Scale).

Part B

ERGONOMIC ANALYSIS

Ergonomic analysis attempts to describe and quantitatively evaluate the various types of activities carried out by the ship, as well as to recognize seasonal activities and those specific to the month of the study.

These data are in fact indispensable in evaluating the impact of schedules on individuals and on performance. They aid in answering the following questions:

- Does the activity carried out by the crew as such contribute to a lowering of performance and an increase in fatigue? Are there months in which this proposition is particularly true?
- How is the study month situated in terms of activities in relation to ordinary work periods? Several questions arise in this regard:
    - Does activity specific to the winter months reinforce the impact of the work schedule (synergy) on the organism and on performance?
    - On the contrary, does this activity lessen this impact?
    - Or, rather, must we conclude that there is no particular link between this activity and the schedules? If so, the hypothesis of the specific nature of activities for January-February does not hold and the conclusions of the study can be generalized to other months of the year.

Regarding the general activity of the ship, the high "stand-by" proportion in the activity reports is a result of the fact that, barring exceptions, the ship is berthed at night, i.e. about half the time.

We should stress the fact that the real percentage of time devoted to incidents does not correspond to the subjective impressions of crew members.

Analysis of this activity by season with regard to the month studied (January-February 1989) revealed the following facts.

The ship was exceptionally assigned to the Trois-Rivières sector. The zone covered was approximately between Sorel and Trois-Rivières; the area explains the lack of time devoted to transit. The proportion of time spent on stand-by in ordinary times varies between approximately 83% (months of March-April and November-December) and about 78.5% (May to October). The months of January and February are usually exceptions to the rule (64.6%). During the month in which the study took place, this proportion was among the highest levels previously observed, 83.6%.

Transit activity varies from 12.7% to 21% in normal times. During the month of the study, it was only 1.5%.

Typically seasonal activities observed previously were incidents, which double in May and June (4.5%), and icebreaking, present only in January-February and representing 10.5% of activity. The month under study is a seasonal month (end of January to end of February 1989) but less typical: only 6.3% of activity was devoted to icebreaking.

Ship activities are described on the basis of the general organization of work on the ship, which includes three departments: deck, engine, and logistics. The individual tasks and activities of those studied led to three questions:

1. Do day workers, with apparently heavy work schedules and activities, also suffer from physiological and psychological disturbances?

2. For those on watch, is it possible to extend the watch in order to lengthen the rest period?

3. What positions may be arranged without extending the watch or increasing personnel by dividing work between watch-keeping and other tasks (eight hours on watch plus four hours of other tasks, for example)?

The third part of this report attempts to provide the basis for a response to these three questions. As well, ergonomic analysis has made it possible to establish that the month under study was representative of normal activity.

At least one of the individuals in Group 3 has apparently had an additional physical burden, and at least one of the individuals in Group 1 has had an apparently lessened physical burden. Everything being more or less equal for the others, the following correction may be made: Group 3 has perhaps been more disturbed than it would have been in normal times and Group 1 has perhaps been less.

This brings us to relate the results of our study to both the month and the particular circumstances under which it was carried out, and the tasks and activities carried out by each individual.

Part C

CHRONOBIOLOGICAL STUDY

The last part of this report attempts to verify five research hypotheses on the physiological and psychological impact of the working hours in effect on the ship.

These research hypotheses may in general be formulated as follows with regard to the groups:

Hypothesis 1:
The Group 1 schedules would have more serious physiological and psychological repercussions than those of the other two groups because:

1. This group is forced to work nights and therefore sleep days.
2. They cannot recuperate (i.e. sleep) more than six hours at a stretch per day.

Hypothesis 2:
The Group 2 schedules would have more serious physiological and psychological repercussions than Group 3 because this group cannot recuperate (i.e. sleep) more than six hours at a stretch.

Hypothesis 3:
The Group 3 schedules would cause the least disturbance because between 1930 and 0600 they allow a normal night's sleep at the proper time. Moreover, we may expect the impact within each group to vary according to the period. Data collection lasted 28 days, a complete work cycle for the team. The literature informs us that under such circumstances, it is possible to identify three periods:

- **Period 1:** Adaptation (day 1 to day 9)
  The literature leads us to expect a first phase of about 10 days, called an adaptation period. This is the phase in which, for Group 1 at least, there would be desynchronization and then resynchronization.
- **Period 2:** Stabilization (day 10 to day 19)
  Once adaptation is complete, a second phase begins which is called a period of stabilization.
- **Period 3:** Fatigue (day 20 to day 28)
  The literature, particular that on work at sea, speaks of sleep disturbance for the crew, causing an accumulation of fatigue as the voyage continues. This has allowed us to hypothesize a third period, fatigue.

Research hypotheses concerning the three periods of the month may be formulated as follows:

Hypothesis 4:
Work schedules would have more serious physiological and psychological repercussions during Period 1 (adaptation) than during the other two periods, whatever group the participant belonged to. It should be added, however, that this period would characterize Group 1 in particular.

Hypothesis 5:
The work schedules would lead to more disturbance during Period 3 than Period 2 in every group. Period 2 would thus be the period of calm between two "disturbed" periods, of which one (the first) would be worse than the other (the third).

In order to verify these hypotheses, the following measurements were taken:

- Body temperature and heart rate were measured continuously during sleep.
- Daily samples of all urinary excretions were kept in order to measure metabolites (potassium, sodium) and catecholamines (adrenaline, noradrenaline, dopamine).
- The muscular strength of each hand was evaluated using a dynameter at the beginning and end of each watch.
- The alertness test (Bakan) was also administered at the beginning and end of each watch.
- The drowsiness questionnaire was administered at the end of each watch.
- A questionnaire on physical and mental activity levels and stress was also completed at the end of each watch.
- A diet and lifestyle questionnaire (cigarettes, tea, coffee, alcohol, bananas, vanilla, cheese, medication) was distributed at the end of the day.

The analysis included three stages:

- Overall effect of schedules on groups, and according to period
- Effect of confounding variables
- Stratified analysis when a confounding variable has shown significant differences.

The statistical tests used were the Student t-test for differences between means and the Fisher F test for variances.

The results made it possible to draw two conclusions with regard to the hypotheses:

1. Group 3 appears just as disturbed by the schedules as Group 1. Group 2 appears the least disturbed.
2. Period 1 is more disturbed than Period 2 and Period 3, but there is no significant difference between Periods 2 and 3.

CONCLUSIONS AND RECOMMENDATIONS

The first major conclusion of this study relates to the day workers (Group 3): they are subject to disturbances comparable to the group on the 0000 to 0600 and 1200 to 1800 watch (Group 1). The group on schedules opposite to these (Group 2) is less disturbed.

These results agree with the literature regarding the specific nature of work at sea, which is disturbing and not comparable to work on land. The literature stresses sleep problems on board ship (Rutenfranz et al., 1988). We did not require the participants in the study to state their period of sleep and recreation. We know from past interviews on board that individuals working watches generally take two rest periods. Measures of temperature and heart beat were taken for the main rest period for workers on watch: the period from 0600 to 1200 for Group 1 and the period from 0000 to 0600 for Group 2.

However, for Group 1, the second period from 1800 to 2400 may also be devoted to recreation. Group 2 would then sleep longer on average (this was confirmed to us by at least one individual).

Group 3 is up from 0600 in the morning to at least 1930 in the evening, thirteen and a half hours at a stretch. Their sleep is often as disturbed as that of the other two groups. Here we must recognize the effect of work at sea, well documented in the literature, and the impact of the long daily hours of work combined with relatively demanding tasks.

We must also compare the results obtained with the content of the specific task of the month studied: one individual at least from Group 3 apparently had an additional physical load, and one individual at least from Group 1 had an apparently lessened physical burden. Everything being more or less equal for the others, the following correction may be made: Group 3 perhaps has been more disturbed than it would have been in normal times and Group 1 has perhaps been less.

This brings us to relate the results of our study to the month and the particular circumstances in which it was carried out, and to the tasks and activities carried out by each individual.

The second major conclusion concerns the observed changes in disturbance. The study shows a desynchronization during the first 10 days, followed by a stabilization in the form of partial adaptation and then a tendency to further disturbance. This is only a tendency: the 28-day period would thus be within tolerable limits.

Finally, our third conclusion concerns the importance of the level of activity (evaluated subjectively) regarding the disturbances observed. Mental activity, for example, had an effect on the average daily change in errors of commission made over the month: when there is little mental activity, the daily average of errors of commission is dispersed through time, whereas they group together when activity levels are mixed. In other words, the results are less stable at the end of the month than at the beginning when activity is low; they are more stable at the end of the month than at the beginning when we consider all levels of activities.

There are thus two reasons (cf. first and third conclusions) why we cannot avoid making a distinction between work stations planned and their **real work load** in our proposals on the arrangement of schedules resulting from our analysis.

This brings us to the recommendations.

At the conclusion of the preliminary analysis of the results, we proposed a re-organization to lengthen the rest period to eight hours. Given that the ship was berthed at night, barring exceptions, it seemed possible to us to envisage extending the rest period. The proposed schedule is shown in Figure 1.

Crew A works eight hours (0000 to 0800), rests four hours (0800 to 1200), works a second shift (1200 to 1600), then rests eight hours. Crew B takes over during Crew A's rest period. Each work crew is thus able to sleep eight hours at a stretch each day.

This organization was rejected by the crew because it implies too long a work period during the evening or night. No solution with two crews was directly applicable. We therefore looked at three-crew solutions and twelve hours of work.

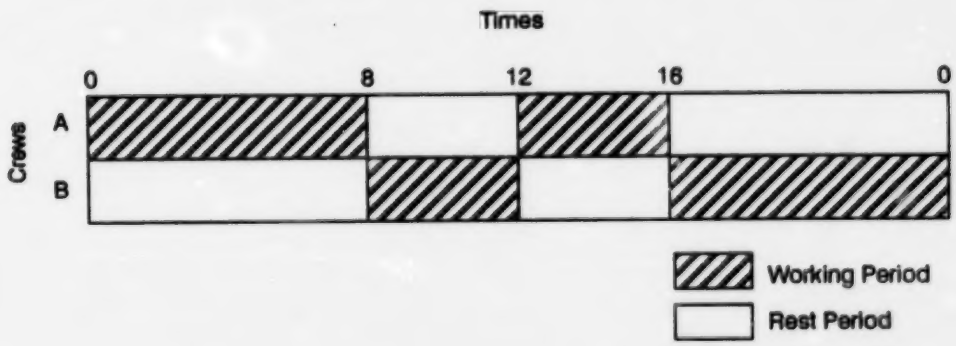

Figure 1: Proposed schedule with two unequal work shifts: one of eight hours and the other of four hours.

We have seen in Part B that with the present crew two work stations could alternate in three shifts. These could be leading seamen, if seamen, who work days on the deck, and oilers are appropriately trained.

For the latter, the present organization, with two engineering officers working in six-hour watches and one engineering officer working days, is justified by the need to have two engineering officers at work during the day.

Considering this constraint, we have proposed the following solutions:

- One schedule (see Figure 2) in which the 24 hours of work are carried out by three crew members. From 1800 to 0600, each post is manned by only one person. From 0600 to 1800, two persons work simultaneously at different tasks. As with the following solutions, these proposals involve a rotation of tasks, that is, one person works only four hours at a given work station and then changes positions for the following four hours during the daytime. For example, Second Lieutenant A carries out the tasks usually assigned (e.g. radar navigation) from 2200 to 0200; rests (sleeps) from 0200 to 0600; occupies a second position (e.g. bridge personnel responsibility) from 0600 to 1000; returns to usual tasks (radar) from 1000 to 1400; then rests for eight hours at a stretch (from 1400 to 2200). At four-hour intervals, individuals B and C occupy the same positions in rotation.

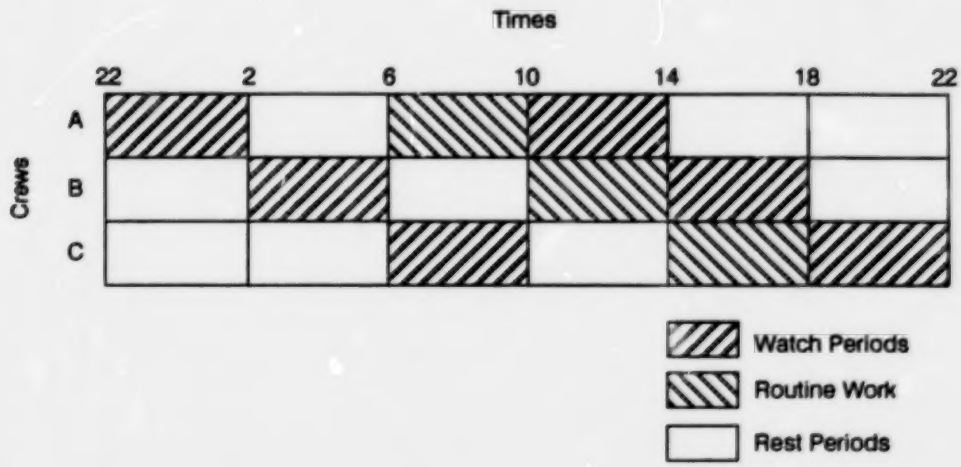

Figure 2: Proposed 12-hour schedule with three work crews with day beginning with the alternative position, beginning at 2200 hours.

- One schedule (see Figure 3) in which the regular position precedes the four hours of the alternative day position. This is the same principle as Figure 2, but applied in different manner and at the same times. Note that it also permits eight hours' sleep at a stretch.

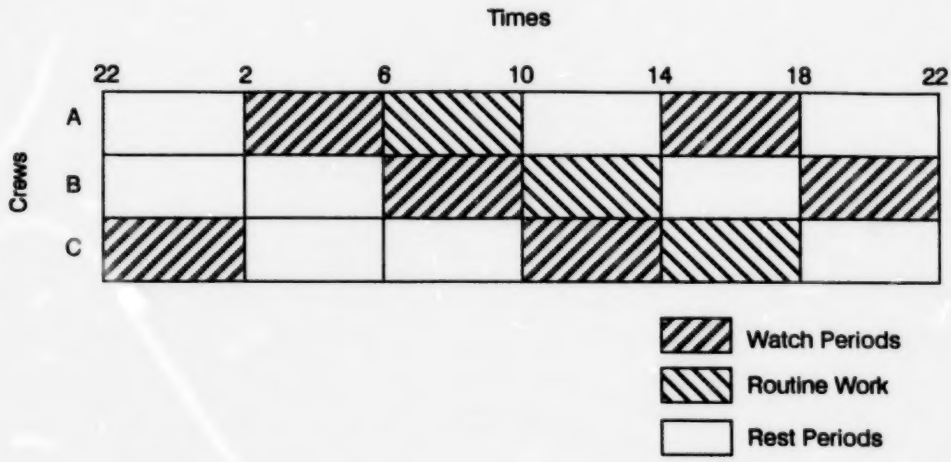

Figure 3: Proposed 12-hour schedule with three work crews with day beginning with the regular position, beginning at 2200 hours.

This solution seems advantageous for two reasons:

1. With the first solution, the eight-hour block of work is preceded by only four hours of rest.

2. With the second solution, not only is the eight-hour block of work preceded by eight hours of rest, but also the watch period is always preceded by a rest period.

One schedule (see Figure 4) is similar to the preceding solution but has different starting times. The first night watch begins at midnight rather than at 2200.

Why favour Figure 3 over Figure 4? The two do seem very similar, but there is an essential difference: Figure 3 allows the occupant of each position to sleep during a significant part of the night, that is, between 0000 and 0600. It shows that Individual A can sleep until 0200 and that Individual C can sleep from 0200 to 0600 (Individual B has a normal night).

On the other hand, in Figure 4, Individual A sleeps from 0000 to 0400 and Individual B does not change, but Individual C has an opportunity to sleep only between 0400 and 1200, which comes very close to daytime sleep.

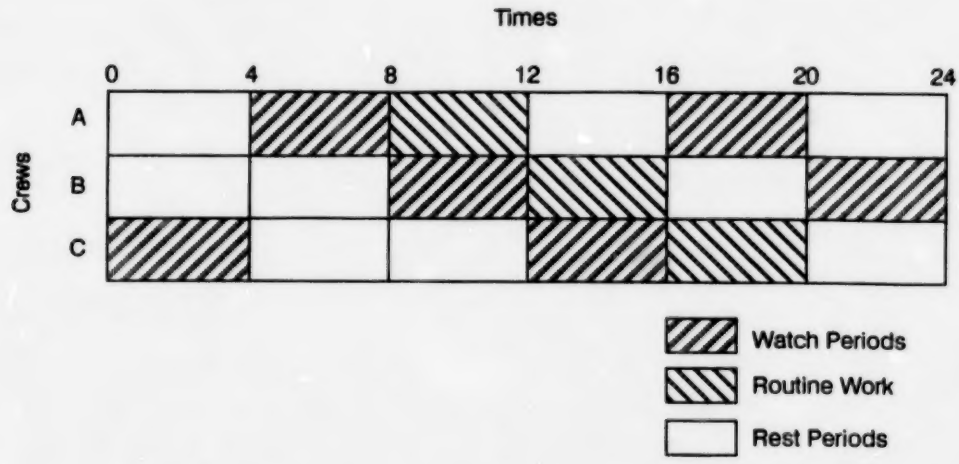

Figure 4: Proposed 12-hour schedule with three work crews with day beginning with the regular position, beginning at midnight.

However, it would be possible to allow each individual to sleep eight hours at a stretch between 0000 and 0800. This could be done by introducing a rapid rotation system (three days maximum) with crews alternating as follows:

A->C->B->A->C—>

B->A->C->B->A—>

C->B->A->C->B—>

Figure 5 shows schedules arranged in this way.

As a result of these proposals, the oilers tried out the solution presented in Figure 3 and seemed satisfied, since they asked that it be officially introduced. The other members of the crew working watches also seemed interested. For lieutenants and engineering officers, this would require an increase in strength. The study brought up the question of the indissociability in work organization between work load and schedules. Even if some periods are relatively calm, it is imperative that work scheduling take into consideration times when the ship is most in demand and, particularly, when the stakes in terms of safety are the greatest, that is in search and rescue work.

Finally, the choice of 28 days for the length of the work cycle appears wise. All things being equal (six-hour shifts or twelve-hour shifts), the results of our analyses confirm this. Although we did not have an opportunity to verify it empirically, the results obtained (curves which destabilized in the last days) seem to indicate that it would not be wise to lengthen this period without preliminary experimentation.

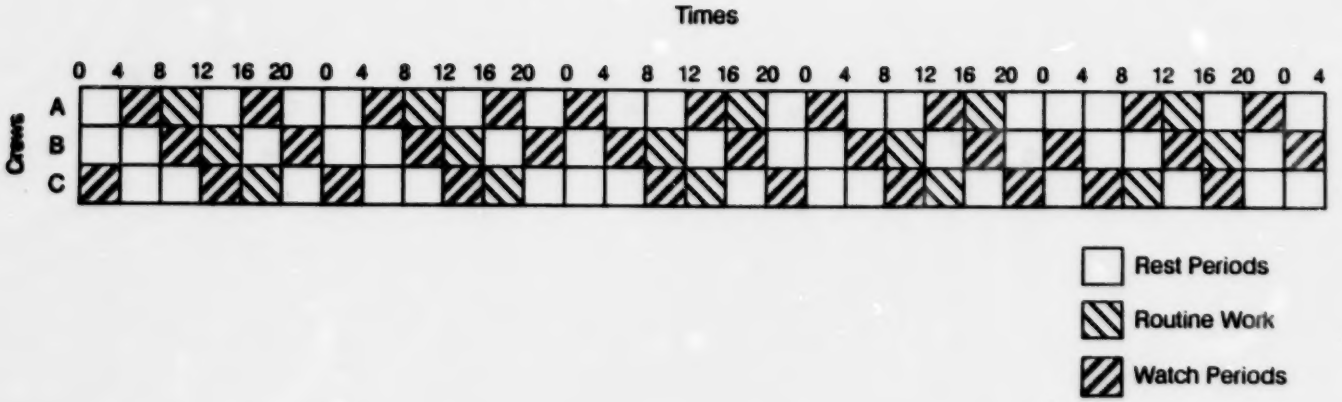

Figure 5: Proposed 12-hour schedule with three work crews with day beginning with the regular position, beginning at midnight with positions rotating over two days.

BIBLIOGRAPHY

Aschoff, J. (1978). Features of circadian rhythms relevant for the design of shift schedules, *Ergonomics*, 21, 10, 739-754.

Bakan, P. (1959). Extroversion-introversion and improvement and auditory vigilant task. *British Journal of Psychology*, 50, 325-332.

Carpentier, J., Cazamian, P. (1977). *Le travail de nuit – effets sur la santé et la vie sociale du travailleur*. Genève : Bureau international du travail.

Quéinnec, Y., Teiger, C. et Terssac, G. de (1985). *Repères pour négocier le travail posté*. Toulouse : Université de Toulouse – Le Mirail.

Reinberg, A., Ghata, J. (1982). *Les rythmes biologiques*. Paris : Presses Universitaires de France.

Rutenfranz, J., Plette, R., Knauth, P., Condon, R., De Vol, D., Fletcher, N., Eickhoff, S., Schmidt, K.H., Donis, R., Colquhoun, W.P. (1988). Work at sea: A study of sleep, and of circadian rhythms in physiological and psychological functions, in watchkeepers on merchant vessels, II. Sleep duration, and subjective ratings of sleep quality. *International Archives of Occupational and Environmental Health*, 60, 331-339.

Vries-Griever, A.G.H. de, Meijman, T.F. (1987). The impact of abnormal hours of work on various modes of information processing: A process model on human costs of performance. *Ergonomics*, 30, 9, 1287-1299.